

# CRS Report for Congress

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## Homeland Security: Defending U.S. Airspace

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### Summary

The September 11<sup>th</sup> attacks have drawn attention to U.S. air defense. Protecting U.S. airspace may require improvements in detecting enemy aircraft and cruise missiles, making decisions on how to address these threats, and intercepting them. A number of options exist in each of these areas, and must be evaluated. The Department of Defense will likely consider a variety of issues in their evaluation, including expediency, cost, and minimizing conflicts with civilian air traffic. This report will be updated.

### Background

In response to the Cold War threat of Soviet bombers and cruise missiles, the Department of Defense (DoD) established the North American Air Defense Command (NORAD) in 1958.<sup>1</sup> During the Cold War, NORAD deployed a network of radars, fielded a complex of surface-to-air missiles (SAMs) around the United States, and commanded a variety of fighter aircraft. The emergence of intercontinental ballistic missiles in the 1960s drew attention away from U.S. air defenses. The air and cruise missile threat appeared to decline further with the fall of the Soviet Union in 1991 and growing U.S. superiority over other hostile air forces. Because an air attack on the United States appeared relatively unlikely, DoD reduced resources devoted to this mission. By September 11, 2001, for example, only 14 Air Force fighters at seven bases were prepared to protect the continental United States (CONUS) from air attacks.<sup>2</sup> This number has subsequently been increased to over 100.

Today, NORAD operates radars in the United States and Canada, oriented outward, to detect air attacks from foreign countries. NORAD augments these radars by communicating with the Federal Aviation Administration (FAA), which operates its own

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<sup>1</sup> For more information about cruise missiles and proliferation see CRS Report RS21252. For more information about NORAD, visit its website at [<http://www.norad.mil>]

<sup>2</sup> Adam Hebert. "Ongoing Operations Made NORAD Response to Sept. 11 'Seamless.'" *Inside the Air Force*. December 21, 2001.

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radars, and by flying E-3 AWACS aircraft. NORAD commands F-15 *Eagle*, F-16 *Falcon*, and Canadian CF-18 fighter aircraft flying combat air patrols (CAP) and on strip alert (prepared to take off on short notice). NORAD's Command and Control (C<sup>2</sup>) centers are located at Cheyenne Mountain Air Station (CO), Elmendorf AFB (AK), Tyndal AFB (FL), and Canadian Forces Base, (Winnipeg Manitoba). Due to the September 11 attacks, and the growing threat of cruise missiles, some policy makers are re-evaluating today's modest U.S. air defenses. Improving defense of U.S. airspace poses numerous challenges to defense planners, who must assess the pros and cons of several military options. As part of its oversight responsibilities, Congress will likely be called upon to assess these options and help determine the most effective mix of systems employed.

## Air Defense Challenges

Effectively protecting U.S. airspace requires detecting threatening aircraft and cruise missiles, making decisions on how to address these threats (called "command and control", or C<sup>2</sup>), and negating these threats.

**Surveillance.** Detecting and tracking airborne threats to the United States are complicated by environment and enemy tactics. The large volume of airspace that must be surveyed presents one key environmental challenge. Airspace over the continental United States is estimated at approximately 3 million square miles.<sup>3</sup> Enemy tactics could include flying low to the ground, which makes detection difficult, or applying stealth technology, which reduces an aircraft's vulnerability to radar detection. As the September 11<sup>th</sup> hijackers demonstrated, turning commercial or civil aircraft into weapons is another tactic that would make threat detection difficult.

**Command & Control.** Expediently identifying airborne threats, and accurately verifying that they are not civilian or friendly military aircraft is a key air defense challenge. The large amount of air traffic within CONUS will likely make separating "friend from foe" difficult. FAA data show that on a given day, over 80,000 distinct domestic commercial aircraft movements (e.g. departures, overflights) take place over CONUS.<sup>4</sup> These 80,000 aircraft movements do not include international flights, or the approximately 200,000 civil aircraft in the United States that fly some 24 million flight hours annually. Nor does this number include military aircraft that fly within both civilian and military airspace. Air defense C<sup>2</sup> over CONUS is further complicated by the fact that decision making will not be a solely military enterprise. Civil entities such as the FAA, and the U.S. Customs Service, and military authorities will require seamless communications and hardware interoperability to make effective decisions.

**Intercept.** Aircraft and cruise missiles can be shot down by anti-aircraft artillery, surface-to-air missiles (SAMs), or aircraft using guns or air-to-air missiles. In dire situations, they may also need to shoot down hijacked civilian aircraft, although negating this threat in other ways will likely be preferred in most circumstances. Minimizing civilian casualties both in the air and on the ground may be a key challenge, especially if

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<sup>3</sup> R.W. Rogers. "Terrorists Exploited U.S. Air Defense." *Newport News Daily Press*. October 7, 2001. p.1.

<sup>4</sup> Three dates were selected randomly. September 5, 2001: 80,228 movements, April 11, 2002: 85,617, and November 13, 2002: 82,759. [<http://www.apo.data.faa.gov/faaatadsall.htm>]

the threatening aircraft or missile carries weapons of mass destruction. Adequately covering the large number of potential targets (e.g. cities, nuclear power plants, dams, military facilities, national buildings and monuments) will also be challenging.

## Options and Issues

Following the terrorist attacks of September 11, 2001, DoD increased the resources devoted to CONUS air defense by deploying an aircraft carrier to New York harbor and by flying fighter CAPs over major cities. NATO allies contributed to this effort (called *Operation Noble Eagle*) by flying AWACS aircraft over CONUS.<sup>5</sup> Although these efforts were welcome they are unsustainable in the long term. DoD must still develop a long term plan for improving air and cruise missile defense of CONUS, which will likely be of great interest to Congress.

When considering air defense options DoD may evaluate factors such as expediency, potential impact on commercial and civil air traffic, potential competition with other military needs, and minimizing collateral damage and civilian casualties. Designing a defense that can address the whole range of potential threats (e.g., enemy bombers, stealthy cruise missiles, and hijacked commercial aircraft), yet be optimized to address the most likely or most dangerous threat may also be a key challenge.

Cost is another key consideration. Estimated costs for air and cruise missile defense of CONUS vary widely depending on assumptions regarding the threat (e.g. number of attackers, flight characteristics, and payload), what is to be protected, system effectiveness (the number of “leakers” that is acceptable) and the exact mix of systems deployed. A 1986 study estimated that a system capable of defeating a Soviet air and cruise missile attack would cost on the order of \$70 billion.<sup>6</sup> A 1989 study estimated that fielding a system that could defend the 20 largest U.S. cities and 50 military installations from a large scale air and cruise missile attack would cost between \$54 and \$170 billion, depending on the exact mix of forces deployed.<sup>7</sup> A more contemporary study suggests that an air and cruise missile defense system for CONUS could cost in the neighborhood of \$30 billion, with annual operating costs on the order of \$1 billion.<sup>8</sup>

**Surveillance.** Surveillance radars can be divided into three categories: ground-based, airborne, and space-based. The primary advantage of ground-based radars is that they tend to be less expensive to field and operate than other radars. A shortcoming of ground-based radars is that they tend to have trouble detecting low flying aircraft. Features such as mountains and buildings block or “clutter” the radar picture, and the

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<sup>5</sup> The 2002 Winter Olympics in Salt Lake City also brought heightened attention and resources to air defense over Utah for the two week event.

<sup>6</sup> Barry Blechman, Victor Utgoff. “The Macroeconomics of Strategic Defenses.” *International Security*. Winter 1986-1987. Vol II, No. 3. pp. 33-70.

<sup>7</sup> Arthur Charo. *Continental Air Defense. A Neglected Dimension of Strategic Defense*. CSIA Occasional Paper No. 7. Harvard University. 1990. P.43.

<sup>8</sup> *Protecting the American Homeland*. Chapter 2. Brookings Institution. Washington, DC. 2002.

Earth's curvature leaves gaps in coverage that low-flying threats can exploit.<sup>9</sup> NORAD already operates a network of ground based radars, and they will likely serve as one component of a CONUS defense surveillance system. Improvements in this network may be considered however, including upgrading the radar to improve its ability to detect stealthy threats, deploying more radars to cover gaps in current coverage, and fielding radars that survey airspace within CONUS, to augment today's outward looking radars.

Airborne radars offer some advantages over ground based radars: they are more mobile. Because they operate tens of thousands of feet above the Earth, they are not as subject to radar clutter, and are thus well suited to detect low flying, and in some cases stealthy, aircraft. The E-3 AWACS and E-2C *Hawkeye* surveillance aircraft are examples of current airborne sensors. Their main disadvantage is that they cost more to field and operate than ground-based radars. The Air Force estimates that the E-3 alone costs \$123 million in 1998 dollars. The FPS-117 long range air search radar that forms the backbone of NORAD's North Warning System, in contrast costs between \$5.8 and \$22 million.<sup>10</sup> Operating costs for aircraft are similarly higher than operating costs for ground systems.

Unmanned Aerial Vehicles (UAVs) use has increased militarily and commercially. Some suggest that UAVs could help conduct surveillance over CONUS for enemy aircraft and cruise missiles. While UAVs cost less to field and operate than manned aircraft, concerns exist about operating these aircraft over populated areas or in airspace heavily used by civilian aircraft. The FAA currently prohibits UAVs from flying in commercial U.S. airspace, although these restrictions could be changed. Also, today's UAVs operate sensors optimized for ground surveillance, not air surveillance. Using UAVs for air defense would require replacing the sensors on current UAVs or fielding new UAVs.

Radars deployed on aerostats — unmanned balloons on tethers — are less expensive than surveillance aircraft, and can also detect low flying aircraft and cruise missiles. Aerostats are attractive because of their long “on-station time.” They can remain aloft for months at a time. Aerostats cannot fly, cannot be moved rapidly, and may prove some hazard to civilian aircraft. Aerostats are currently deployed by DoD for military purposes, and by the U.S. Customs Service to search for drug smuggling aircraft and boats. Deploying radars on manned or unmanned airships (blimps) may be a middle ground between aircraft and aerostats: costs and flexibility lie somewhere between the two. NORAD has reportedly expressed interest in using airships for homeland defense.

DoD is also studying the efficacy of deploying radars on satellites. The most mature study effort (the *Discoverer II*) was designed to detect and track moving ground targets, not airborne targets. *Discover II* was terminated by Congress in 2000 due to concerns about cost and the ability of DoD to make effective use of the voluminous radar data.<sup>11</sup>

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<sup>9</sup> Radars are also deployed on ships. Because the ocean is smooth they do not suffer the same clutter as ground based radars. They are limited by the earth's curvature, and have difficulty detecting low-flying aircraft at long range. They can survey U.S. airspace near coastal areas only.

<sup>10</sup> Paul Mann “New Air Defense Pact Provides Canadian Takeover of DEW Line.” *Aviation Week & Space Technology*. March 25, 1985.(Notes \$58.8M sale of 10 radars). “DoD Announces Potential \$22 Million Sale of FPS-117 Radar to Jordan.” *Defense Daily*. April 19, 2002.

<sup>11</sup> U.S. House of Representatives. H.Rept. 106-754 (H.R. 4576) July 17, 2000. p.264.

Space-based radars applicable to air defense surveillance may be developed in the long term, but questions about their technical feasibility and cost effectiveness remain.

**Command & Control.** Several options exist for improving NORAD's air defense C<sup>2</sup> capabilities. One menu of options focuses on improving NORAD's ability to detect, identify, and track threats originating from CONUS. DoD has engaged in a \$30 million upgrade of NORAD's computers to better integrate FAA and military airspace management systems.<sup>12</sup> Other options that might be pursued would be to make permanent, ad hoc C<sup>2</sup> relationships devised after September 11<sup>th</sup> to integrate NORAD radars with Customs Service aerostats and with the Navy's *AEGIS* ship radars. NORAD may also wish to find ways to leverage the Civil Air Patrol for air defense. The Civil Air Patrol is an auxiliary of the Air Force and typically flies disaster relief, search and rescue, and counter drug surveillance missions. Properly integrated with NORAD C<sup>2</sup>, however, the Civil Air Patrol might perform niche air defense functions.

A second menu of options pertains to improving NORAD's ability to counter an attack by low flying and stealthy cruise missiles. DoD has attempted to improve theater air and cruise missile defenses by promoting interoperability among the services and creating a Single Integrated Air Picture. DoD may consider expanding these efforts to make them applicable to CONUS air defense. It is not clear that the C<sup>2</sup> improvements designed to counter cruise missile attacks would also help detect and counter threats originating from inside CONUS. Another option for improving C<sup>2</sup> would be to mandate improved Identification Friend or Foe hardware and procedures for civilian aircraft that operate near high risk areas (e.g. highly congested airspace, power plant, or military bases.) This could help reduce the number of accidental incursions into restricted airspace (which require a military response and risk downing a civilian aircraft) but would likely be resisted by civilian pilots due to increased costs.

**Intercept.** Similar to the options for air defense surveillance, options to intercept aircraft and cruise missiles can be divided into surface- and air-based, each offering strengths and weaknesses. Fighter aircraft are well suited to shoot down other aircraft and cruise missiles. They are inherently deployable and flexible. They also tend to cost more to procure and operate than other intercept options. Immediately following September 11<sup>th</sup>, the Air Force began 24 hour combat air patrols over New York and Washington, and intermittent patrols over other major cities. Cost estimates of these patrols vary between \$100 million to \$200 million per month.<sup>13</sup> The Bush administration requested \$1.3 billion for combat air patrols in FY03. These costs, the strains they put on pilots and other personnel, and the unanticipated wear and tear they put on fighter aircraft have led DoD officials to recommend reducing these patrols and search for other intercept solutions.<sup>14</sup>

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<sup>12</sup> Gail Kaufman. "Small Job to Shape USAF Network Plans." *Defense News*. January 6, 2003.

<sup>13</sup> Eric Schmitt. "U.S. to End 24-Hour Fighter Jet Patrols Over New York." *New York Times*. March 18, 2002. John Liang. "NORTHCOM Nominee Recommends Scaling Back Combat Air Patrols." *Inside the Air Force*. June 21, 2002.

<sup>14</sup> In the two years following September 11, 2001, NORAD scrambled fighters or diverted patrols more than 1,500 times. Source: Catherine Tsai. "Two Years After Terrorist Attacks, Northcom Poised to Become Fully Operational." *Army Times.com* September 11, 2003.

The costs of using combat aircraft for air defense might be reduced in three ways. First, some suggest keeping combat aircraft on 15 minute strip alert, rather than having them fly patrols. During the Cold War, NORAD kept aircraft on strip alert at over 100 sites.<sup>15</sup> Some loss of responsiveness would be expected, and this would have to be weighed against the amount of money saved. On January 6, 2002 a 15 year old boy flew a private aircraft into an office building in Tampa, FL, passing over MacDill AFB in the process. The Air Force's inability to intercept the aircraft before it crashed suggests how moving aircraft from patrols to strip alert may reduce intercept effectiveness. Another way to reduce the cost of using combat aircraft for air defense would be to design and build cheaper aircraft specifically designed for this mission. One company claims it can build an interceptor for \$4 million, a fraction of the cost of modern fighters.<sup>16</sup> The feasibility of building such a low cost combat aircraft is still unproven. A third potential way of reducing aircraft costs would be to field air-to-air missiles on UAVs. The Air Force is currently experimenting with the *Stinger* on its Predator UAV, which reportedly engaged in a dogfight with an Iraqi fighter aircraft.<sup>17</sup>

DoD has fielded numerous SAM systems. The Army's *Patriot*, the Marine Corps' *Hawk*, and the Navy's ship-based Standard Missile, are some examples of SAMs that could be part of a CONUS air defense. SAMs tend to be less expensive than combat aircraft, and they carry more missiles. The *Hawk* missile system, for instance, costs approximately \$25 million, and a battery can fire 48 missiles.<sup>18</sup> SAM warheads are generally larger than air-to-air missile warheads, which gives them more destructive power. Unlike aircraft, SAMs cannot chase enemy aircraft and cruise missiles, and careful thought must be given to their deployment. Unlike combat aircraft, SAMs cannot perform visual identification of a target to help determine whether it is a friend or foe.

Although surface-to-air guns and missiles are well established air defense interceptors, directed energy weapons, such as lasers, are still experimental. Lasers might be able to intercept enemy aircraft much faster and at greater ranges than today's SAMs. They might also be cheaper. The Air Force's Airborne Laser and the Army's Tactical High Energy Laser are two experimental programs that, while not currently designed to intercept enemy aircraft, might be leveraged to develop future air defense directed energy weapons. The effectiveness of directed energy weapons is still being explored.

Regardless of which systems are eventually deployed, a CONUS air and cruise missile defense system will likely be made up of layered and heterogeneous elements. A mix of fighter aircraft and SAMs (or other options) is typically more attractive than deploying only fighters or only SAMs. Similarly, defense planners will likely lean toward a mix of surveillance platforms and sensors rather than just one type. A mix of systems reduces the chance of "single point failure," complicates an adversary's attack planning, and can make a more effective system. Determining the best mix, however, may be critical.

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<sup>15</sup> Adam Hebert. "DoD Weighs Air Defense options as Patrols Become Unsupportable." *Inside the Air Force*. January 25, 2002. p.1.

<sup>16</sup> Greg Griffin. "Colo. Firm Designs Patrol Jet." *Denver Post*. February 28, 2002. p.2D

<sup>17</sup> "The Predator." *60 Minutes II*, aired on CBS. January 9, 2003.

<sup>18</sup> Hawk Surface-to-Air Missile System. Fact File. [<http://www.hqmc.usmc.mil/factfile>]